

# **CARTOGRAPHIC ACTIVITIES OF GENERAL COMMAND OF MAPPING/TURKEY**

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## **INTRODUCTION**

As a National Mapping Agency of Turkey, General Command of Mapping (GCM) is responsible for the establishment and maintenance of geodetic networks, collecting and structuring topographic data and producing standard topographic map series of Turkey.

The vision of GCM is to become leading agency in the field of mapping in national and international area, raising mapping staff and producing geospatial information covering the needs of 21st century. The mission to reach this vision is to provide military and civilian users with all kind of adequate, consistent, up-to date classic and digital geospatial products in a timely and economic manner.

Cartographic activities of General Command of Mapping (GCM) (Turkey) is briefed under the headings given below. This paper represents only the ideas of authors, not the idea, strategy or position of Turkish Armed Forces.

1. Production Activities,
2. Research Projects,
3. Relations with other organizations.

## **1. PRODUCTION ACTIVITIES**

According to her law of foundation, GCM is responsible for the production of maps needed for defense and development purposes. Therefore, the production of base scale maps at 1/25.000 and other topographic maps at 1/50.000 and 1/100.000 scales which are generalized from base scale maps, 1/250.000 scale Joint Operations Graphics (JOG) series maps and Low Flying Charts (LFC), 1404 series 1/500.000 scale maps as well as 1301 series 1/1.000.000 scale maps covering Turkey are under the responsibility of GCM.

Beside these products, GCM is also carrying out the production of small scale thematic maps and Raised Plastic Relief Maps. The other data produced by GCM is Gazetteer of Turkey in which geographical features extracted from Physical Map of Turkey at scale 1/250.000.

### **a. 1/25.000 Scale Topographic Map Production**

Base scale of Turkey's topographic maps is 1/25.000 and the country is covered with about 5547 sheets. Revision and reproduction of base map series is a continuous work. Most of other topographic maps at smaller scale are based on this map. The first and second editions of base map series are completed between 1951-1972 and 1957-1996, respectively. Moreover, maps of some regions which are developed rapidly are published for several times - edition 5, for some regions - since 1977. The third edition of base map series is being produced by means of digital techniques. By the end of 1999 digital production has begun and by the end of 2012, 4269 sheets (~ 77% of total), were produced digitally.

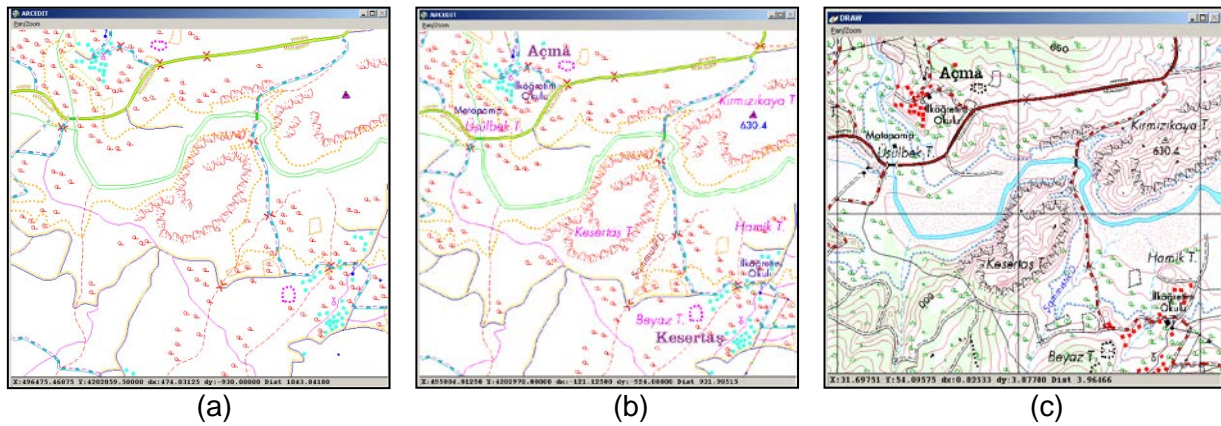
1/25.000 scale digital topographic map production system, KARTO25 has been developed locally on top of ESRI ArcInfo Work Station technology. Data is collected in vector format under 9 different features. Each class is divided into 3 coverages as point, line and polygon, while annotation features are stored in a different class. Table-1 shows 10 classes which form the digital map.

At the end of the production, both vector and raster maps are obtained. The vector product is called "1/25.000 scale Cartographic Vector Map" while the raster product is called "1/25.000 scale Cartographic Digital Map". The resultant raster and vector maps are being stored in digital media.

Figure-1 shows different views of 1/25.000 Cartographic Vector Map.

No	CLASS (English)	CLASS (Turkish)	Abbreviation
1	Boundary	Sınırlar	bnd
2	Elevation	Yükseklik	ele
3	Hydrography	Hidrografiya	hyd
4	Industry	Endüstri	ind
5	Physiography	Fizyografiya	phy
6	Population	Yerleşim	pop
7	Transportation	Ulaşım	tra
8	Utilities	Tesisler	uti
9	Vegetation	Bitki Örtüsü	veg
10	Annotation	Yazı	yazi

**Table-1:** Themes of 1/25.000 Scale Cartographic Vector Map



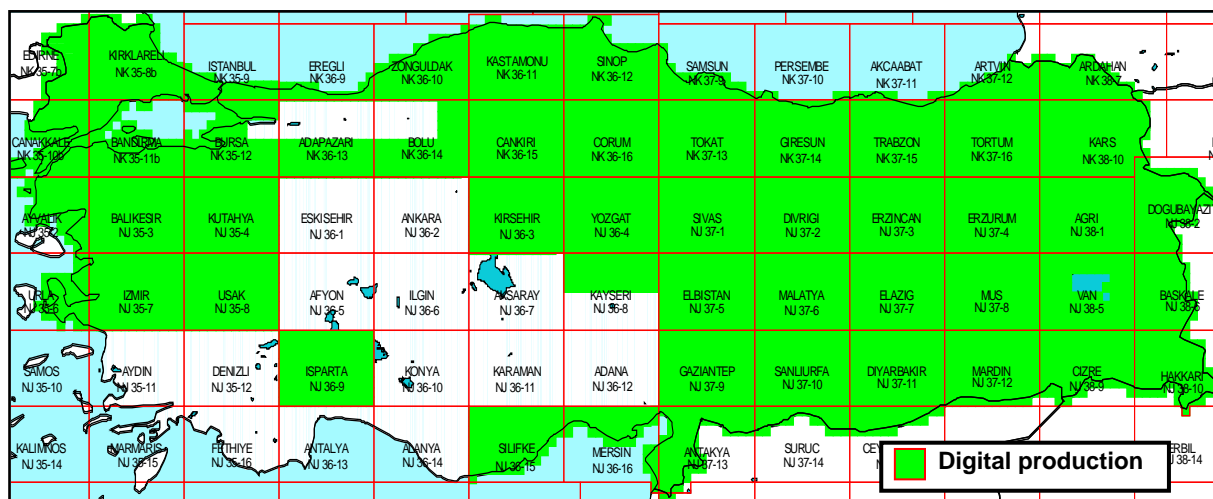
**Figure-1:** Different Views From 1/25.000 Cartographic Vector Map  
(a) Vector data, (b) Vector data and annotations, (c) Vector Map

At the beginning of 2003 heads-up digitizing of photogrammetric revision plates was discontinued and the system was upgraded to digital data exchange between Photogrammetry and Cartography departments. Within the frame of this transition in 2002 “Feature Describing and Symbology Specification”, in 2003 “Data Dictionary” and “Specification for Annotations” and in 2006 “Production Specification” was prepared and published.

Since 2003, the base scale maps have been produced with WGS-84 datum instead of European 1950 (ED-50) with a user note for conversion between two datums. In order to create a seamless library, a quality control and standardization process has been performed and these maps have been archived in UTM projection system. Maps added to this library are also used for computer assisted/automated generalization purposes.

Because cartographic production has been fed by topographic database in ArcGIS since 2011, studies to upgrade this production system to ArcGIS platform is continuing from then on.

The production status by 2013 at this scale can be seen in Figure-2.



**Figure-2: Status of 1/25.000 Scaled Digital Topographic Map Production**  
(As of 31 December 2012, 4269 sheets)

In order to complete the whole 5547 maps covering Turkey in a short time, from the beginning of 2012, 1/25.000 Scale Topographic Map Production (excluding the printing phase) has been carried out by outsourcing. This production covers 1307 sheets and is planned to conclude by the beginning of the 2014.

#### **b. 1/50.000 and 1/100.000 Scale Topographic Map Production**

The whole Turkey is covered by 1450 sheets of 1/50.000 and 387 sheets of 1/100.000 scale maps. Production of these two map series have been completed between 1951-1995 and 1950-1990, respectively. Furthermore, some sheets have been produced as second and third edition.

The production of these non-base scale Standard Topographic Maps, which was successfully carried out with classical methods till 2000, are aimed to be handled on digital environment using “Generalization Techniques” and “KARTO25 data”. In this scope; conventional cartographic production at these scales comprising the steps of generalization, mosaic process, photomechanical downsizing and pressing was discontinued by the end of 2002. A new project called “Computer Assisted Generalization Project” was initiated in 2002 the intent of which is to automate the generalization processes including automatic and interactive processes in the derivation of 1:50.000 and 1:100.000 scale standard topographic maps at an optimum production time with high standardization and automation levels as much as possible.

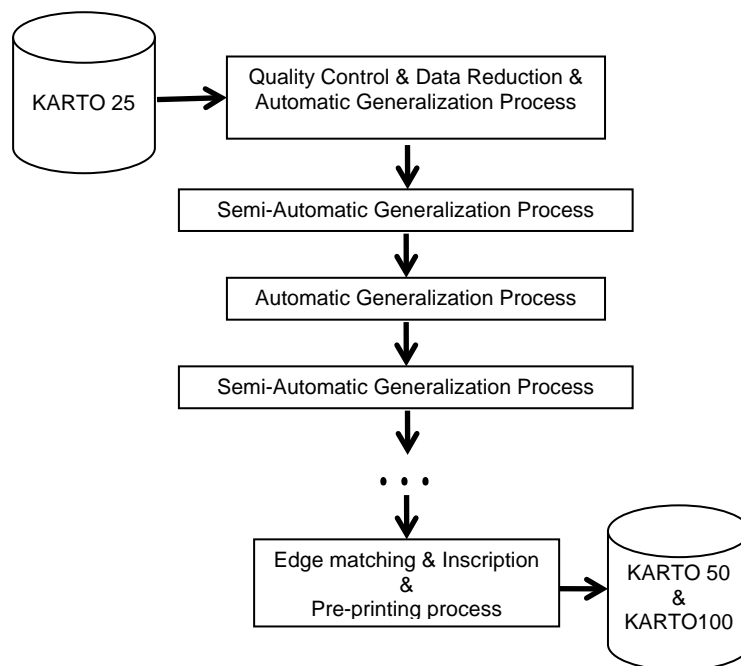
The project has also been extended to cover some further improvements on the final map products. The symbology used in the maps has been enhanced. Dynamic legend has been implemented in the output maps, showing only the symbols used in the relevant sheet instead of using the same legend for the whole sheet series. To accomplish this project, following aims were realized:

- Analyzing, defining and arranging the needed generalization rules,
- Defining and arranging the feature's importance and priority list,
- Defining the generalization parameters,
- Analyzing the needed generalization algorithms,
- Investigating the present algorithms and their applicability to our needs, and modify and/or improve them or develop a new one, if needed.
- Defining the processes and their orders.

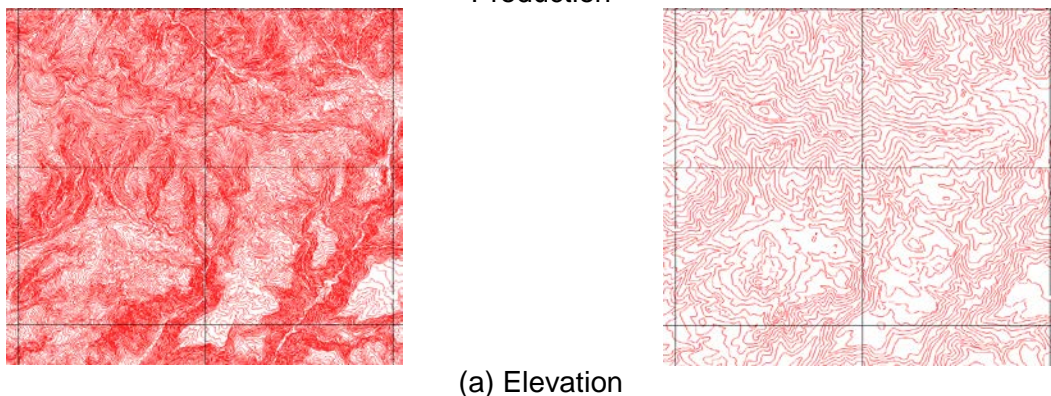
In 2005 the first version of KartoGen software was officially released which was developed by the GCM staffs using visual basic programming language with ESRI ArcGIS environment and its ArcObjects developing components. KartoGen Software is integrated generalization software which consists of intelligent and sophisticated exe. and dll. programs and designed as an extension of ArcGIS, as well.

KartoGen production line includes data quality control, data pre-processing, automatic and semi-automatic generalization toolboxes, edge matching, inscription, control and printing steps (Figure 3). The generalization toolboxes and the other steps are still under improvement. Before the execution of main generalization programs, data pre-processing including data transformation, attribute exchange, adding supplementary fields into feature classes, deleting the unnecessary features, splitting-unsplitting lines etc. are performed automatically. Without any interactivity, this step resolves generalization problems with predefined solutions.

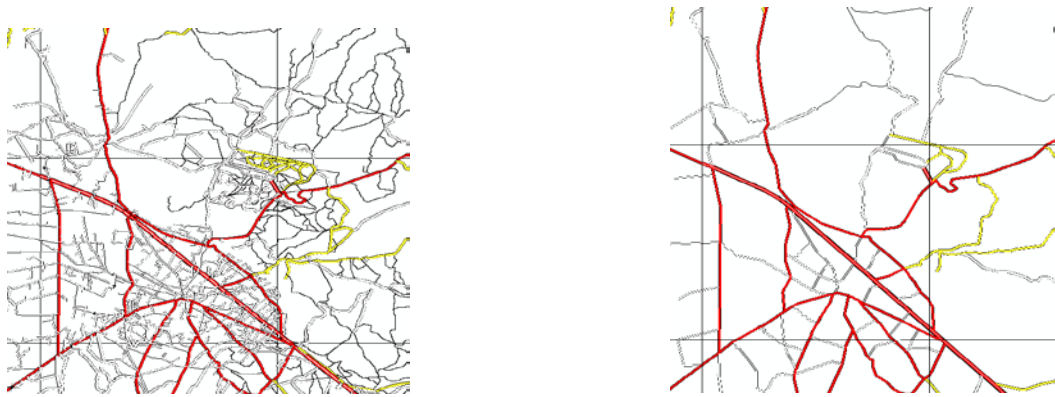
In the subsequent steps, generalization process is concluded with automatic and interactive semi-automatic chain of operations which is called interactive generalization handling 9 feature classes successively. Despite the name “interactive”, this semi-automated step comprises not only the simple human interaction but also certain automated generalization operators and algorithms which are altered as to the different feature classes (Figure-4).



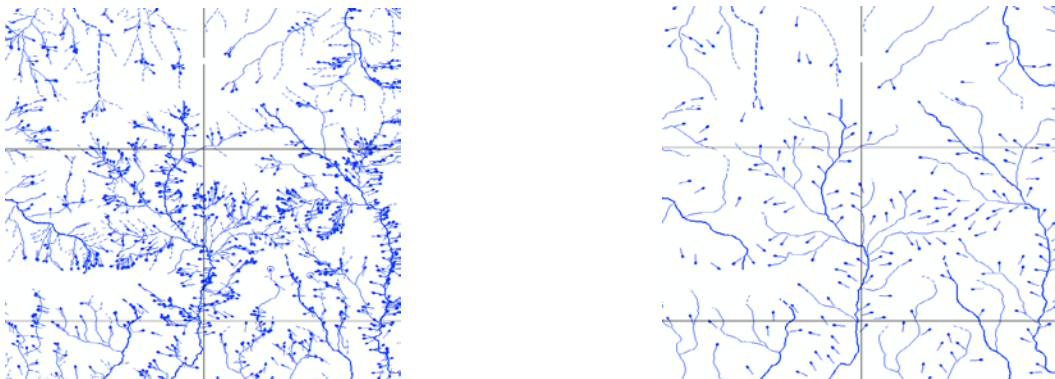
**Figure-3:** Processing steps of 1/50.000 and 1/100.000 Scaled Digital Topographic Map Production



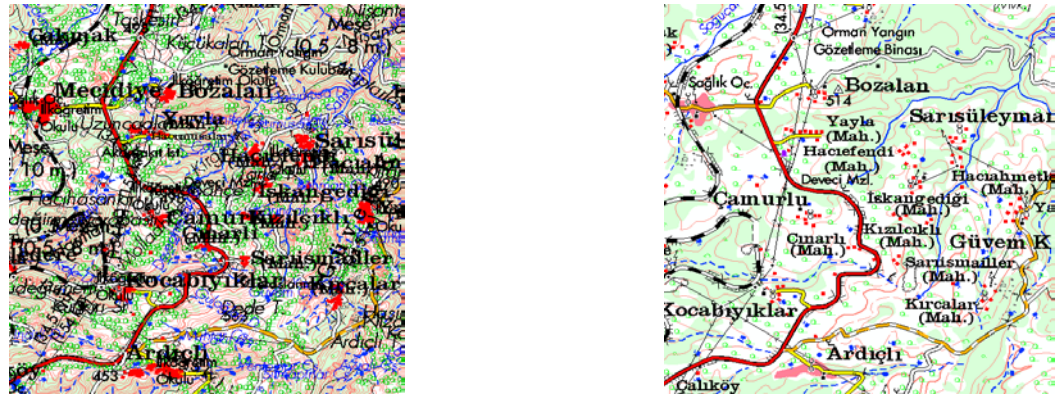




(b) Transportation



(c) Hydrography

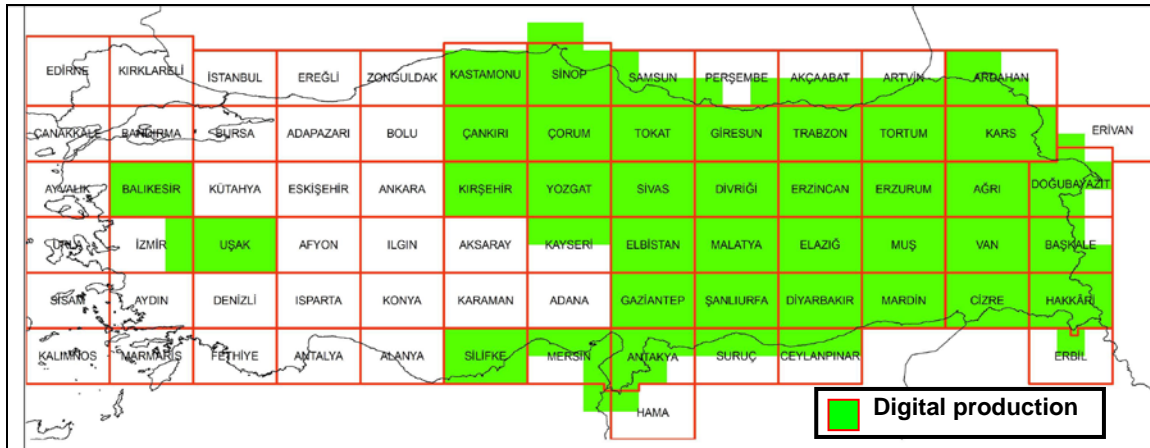


(d) All feature classes

**Figure-4:** Samples of Different Feature Classes Before and After Generalization Process

By the end of 2005, 1/100.000 scale map production, and by the end of 2006, 1/50.000 scale map production have been started. According to statistics, 75% of cartographic processes are carried out automatically and the remaining processes are made interactively. On the other hand, time spent for production decreased to 50 %. It takes an average 40 workdays for a 1/100.000 and an average 15 workdays for a 1/50.000 scale map production. So in the proceeding year of the production of 1/25.000, the smaller scales of 1/50.000 and 1/100.000 maps can be published.

With this production line, **889** 1/50.000 and **241** 1/100.000 scale maps have been produced as of 2013 (Figure-5). All 1/50.000 and 1/100.000 scale maps covering whole Turkey are planned to be completed by the end of 2017.



**Figure-5:** Current Status of 1/50.000 and 1/100.000 Scaled Digital Topographic Map Production (as of December 2012)

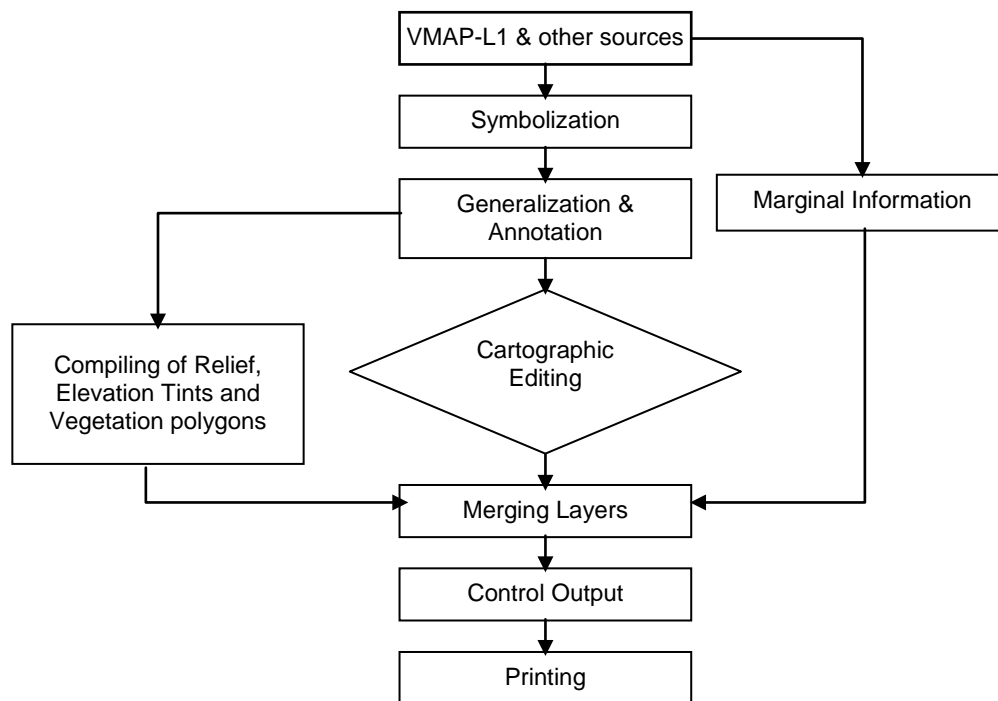
### c. 1/250.000 Scale Map Production (JOG, JOG-A, TFC)

The whole Turkey is covered by 71 sheets of 1/250.000 scale maps. First and second editions of Joint Operation Graphics (JOGs, Air/Ground) are produced in the period of 1971-1973 and 1983-1987 respectively by means of conventional cartographic generalization workflows from topographic maps at a scale of 1/100.000. The third edition is being produced from VMAP L1 database according to the specifications of GCM and NATO STANAG's since 2002. JOG series maps are produced digitally by GCM since 2002. VMAP Level-1 data which generated from different sources is used for this production. Thematic information is collected from JOGs and large scale topographic maps. Aeronautical and other information is taken from Aeronautical Information Products (AIP) from General Directorate of State Airport Authority and Digital Aeronautical Flight Information File (DAFIF), Digital Vertical Obstruction File (DVOF) from Turkish Air Forces respectively.

Production work-flow from VMAP Level-1 database is given in Figure-6. Digital Landscape Model (DLM) required by Map Production System (MPS) is not equivalent to data model of VMAP Level-1; the database schema of VMAP Level-1 is extended. Data is symbolized according to Digital Cartographic Model (DCM). In order to improve graphic readability and produce a map according to JOG specifications, VMAP Level-1 data is generalized by using graphic generalization operations such as simplification, exaggeration, replacement, classification, aggregation.

ESRI and Adobe software products are used in JOG production line. After transforming labels coded in ASCII into Turkish, the base map is formed.

Consistency of all thematic layers is maintained by providing consistency of relief-hydrography, population-hydrography-vegetation and transportation-hydrography-physiography layers. Datum transformation information between ED50 and WGS84 and magnetic declination at epoch 2010 is taken from GCM Geodesy Department.



**Figure-6: Flow Chart of JOG Series Map Production**

Production Line Tool Set/Map Production System (PLTS/MPS) software, is used for re-arrangement of VMAP Level-1 data, cartographic mapping of the information in the database and direct color separation of graphic files in the JOG production. The steps shown in flow chart (Figure-7) are managed by MPS. A sample of standard JOG-Air chart is given in Figure-6. By the end of year 2012, 71 sheets covering Turkey are produced.

#### **d. Low Flying Chart (LFC) Production**

Standard JOG-Air series charts do not fit the needs of some users (especially in low flying heights). In 2009 GCM started a new project which is called 1/250.000 scaled Low Flying Chart Production Project to meet user's requirements. In the first step GCM arranged some meetings to learn more about the user requirements. Then the project continued with a pilot chart production. Finally production line was established and the products were distributed to the users.

The differences between standard JOG-Air and LFC are as follows;

- LFC has much more vertical obstacles than JOG-Air,
- LFC has aeronautical information (which is derived from Turkish AIPs)
- LFC has heliports,
- The font sizes are different from JOG-Air (user requirements)
- The color representation in LFC is different form JOG-Air both in some feature types and in heights.

A sample of standard JOG-Air chart is given in Figure-8 and a sample of LFC chart is given in Figure-9.



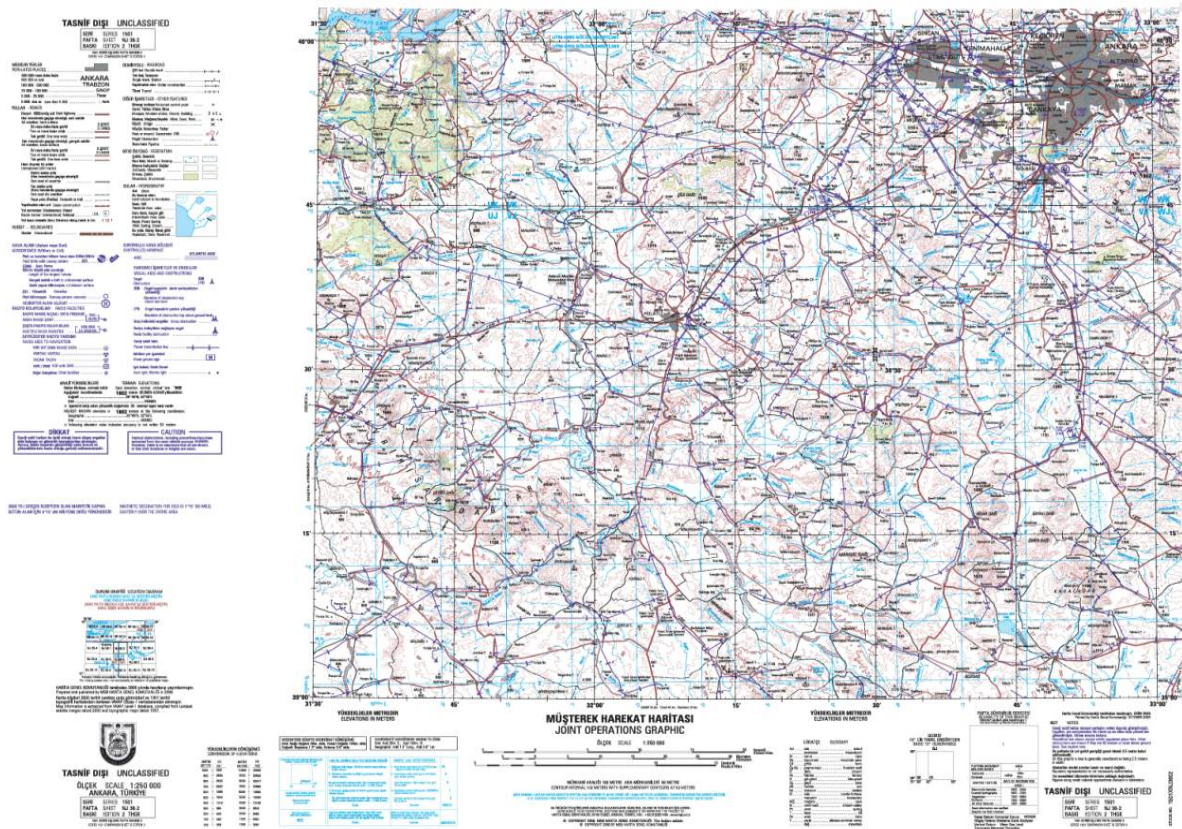


Figure-7: JOG Series Map



Figure-8: Sample of 1/250.000 scaled JOG-Air Chart



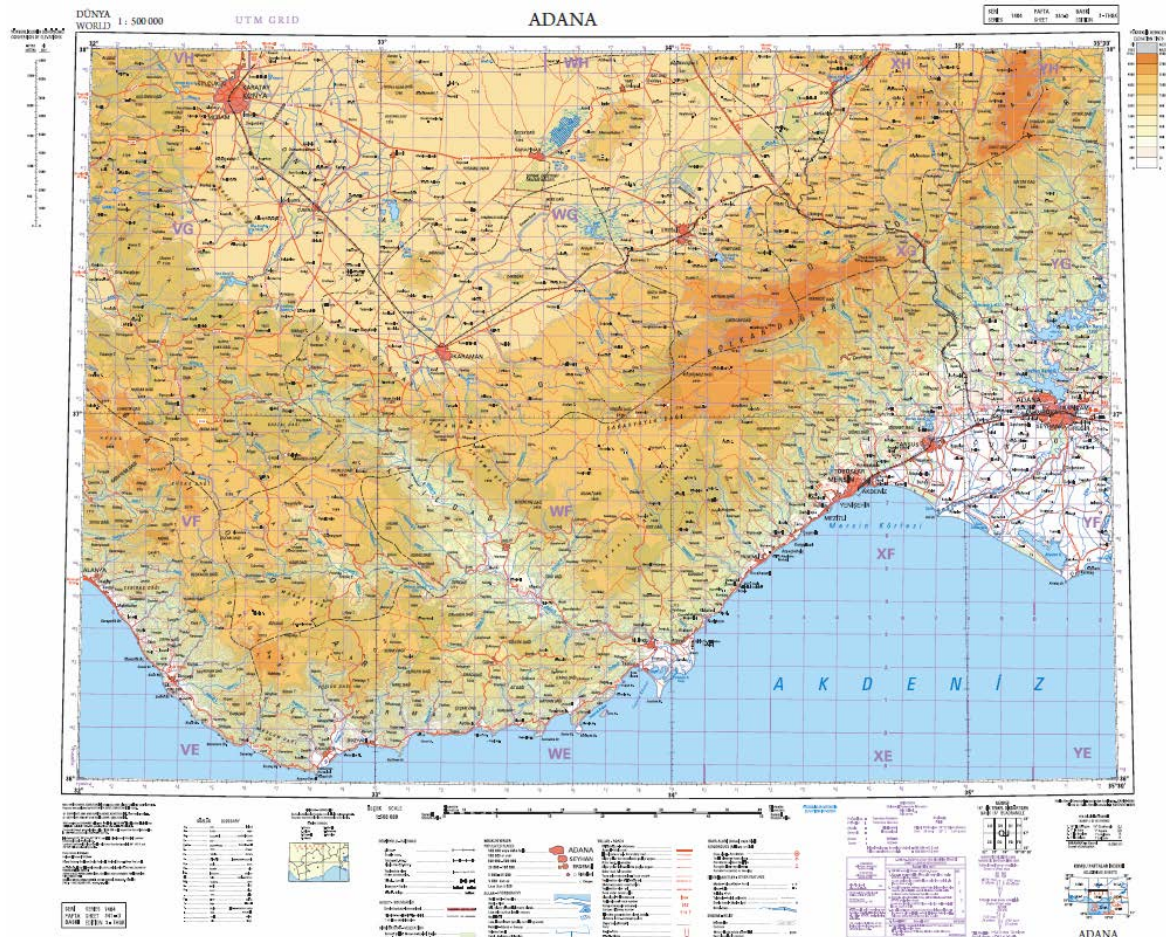


**e. 1/500,000 Scale Topographic and Air Map Production**

Currently GCM is able to produce small scale topographic maps and air charts at scale 1/250.000. GCM is also responsible to publish topographic map series at scale 1/500.000 and 1/1.000.000 namely World Series 1404 and 1301 respectively.

By the end of year 2012, 16 of 19 1/500.000 scaled topographic maps were produced (Figure-10).

GCM is also going to produce 1/500.000 scale TPC series aerial maps from 2013.



**Figure-10: 1/500.000 Scale World Series Map Sample**

## f. Thematic Map Production

Thematic map productions in GCM are going on in various scales (Figure-11). Samples of the thematic maps produced in this period (2007-2012) are as follows;

- Physical Map of Turkey (in scales 1/1.000.000, 1/1.800.000, 1/3.500.000) (Paper&Raised),
- Administrative Units Map of Turkey (in scales 1/1.000.000, 1/1.800.000 ) (Paper&Raised),
- Physical and Political Map of the World (in scale 1/30.000.000),
- Physical Raised Plastic Relief Map of the World (in scale 1/24.000.000)
- Political and Physical Map of Turkey and Surroundings (in scales 1/13.000.000, 1/3.500.000)
- Physical Raised Plastic Relief Map of Turkey and Surroundings (in scales 1/1.000.000, 1/3.000.000, 1/4.250.000)
- Physical and Political Map of the Balkans (in scale 1/2.200.000)
- Physical Raised Plastic Relief Map of the Balkans (in scale 1/2.700.000)
- Physical and Political Map of the Caucasus (in scale 1/1.500.000)
- Physical Raised Plastic Relief Map of the Caucasus (in scale 1/2.000.000)
- Physical and Political Map of the Europe (in scale 1/9.000.000)
- Physical and Political Map of the Afghanistan (in scale 1/2.500.000)





**Figure-11: “Turkey and Surroundings Plastic Relief Map” at Scale 1/1.000.000**  
(With a total size of 354 x 218 cm. and consisting of 16 sheets.)

## **g. Populated Places Databases and Gazetteers**

### **a. Populated Places Data Base of Turkey (PPDB\_T)**

The residential entities (populated places) in hierarchical order from top to bottom are province, district, sub-district and village. Some of the information collected for a populated place are a unique ID number, nationally authorized name of the place, position (title of the 1:25.000 map sheet and grid numbers), geographic coordinates (latitude and longitude).

PPDB\_T is updated continuously using both the toponymy collected during field campaigns and the reports on renaming or foundation of a populated place supplied by Ministry of Interior. The database is used for topographic and mid-scale map productions in General Command of Mapping. Besides, several universities, research institutions, military organizations, private and public organizations request this data for various purposes.

### **b. Mid-scale Gazetteer of Turkey at scale 1:250 000**

First version of Mid-scale Gazetteer at scale 1:250.000 (Gazetteer\_250\_v1) containing features rendered on Joint Operations Graphic (JOG) maps at scale 1:250.000 was accomplished in 1997–1998 consisting of almost 45.000 names in NATO STANAG-2213 standards. It comprises 58 types of geographical features such as populated places, places of cultural importance, transportation, lakes, streams, mountains, physiography, vegetation, and regions of major importance.

Integrating Populated Places Database of Turkey (PPDB\_Y) and Gazetteer\_250\_v1, the second version (Gazetteer\_250\_v2) is created by means of extracting natural features and populated places from Gazetteer\_250\_v1 and PPDB respectively in July 2006. This gazetteer comprises 52.500 geographical names.

The Gazetteer\_250\_v2 will be updated by using produced JOGs which covers more than two thirds of Turkey. The attributes captured for each feature are as follows; name, feature type, easting, northing, longitude, latitude, JOG sheet and date of publication. The feature



type is in compliance with NATO geo-name databases. This gazetteer is released from General Command of Mapping's web site ([www.hgk.msb.gov.tr](http://www.hgk.msb.gov.tr)).

## 2. RESEARCH PROJECTS

### Holographic Map Production System

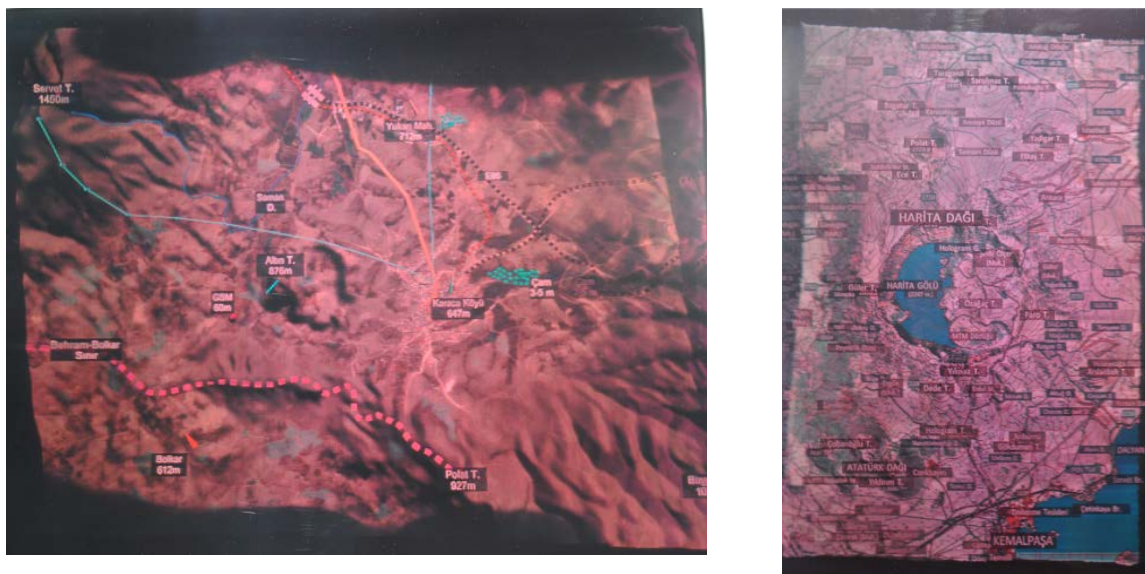
A new R&D Project was conducted at 2008, to research the applicability of Holography on Cartographic Map Production System. The term "Holographic Cartography", a new field of science and discipline, was proposed for the first time by General Command of Mapping at International Cartography Association Conference (ICC) 2009 in Chile.

The main objectives of this project are listed below:

- To research the applicability of holography on cartographic map production principles and rules.
- To build a Holographic Map Production Laboratory.
- To construct a Holographic Map Production System to manufacture massive amounts of map sheets.
- To develop software that converts, edits and generalizes 2D Topographic Vector Map Data into 3D Digital Holographic Map Data.
- To build a database that serves 3D Digital Holographic Map Data to end-users.

Several prototypes of the Holographic Maps (Figure-12) have been developed and exhibited at some national and international conferences. Due to the project timeline, some new and advanced techniques are planned to be implemented until the end of 2014. Also field tests will be conducted after development of the new prototypes.

Consequently, it can be said that with the capability of depicting 3D data on a 2D material could open a new era for the cartography in the near future. The need for real 3D cartographic digital data is the main handicap of this project. It is essential that to develop complex software to do tasks such as convert, edit and generalize 2D digital data in 3D space.



**Figure-12:** The prototypes of holographic maps

### 3. RELATIONS WITH OTHER ORGANIZATIONS

In order to contribute to the national/international cooperation and collaboration, to catch up with the latest technological developments and benefit from international expertise and provide the staff with fast and updated information, GCM having been National Mapping Agency (NMA) for Turkey is eager to work closely with national/international organizations and national mapping agencies.

Geographic activities in NATO have been carried out in accordance with the decisions taken by "NATO Geographic Conference (NGC)" and "NATO Standardization Agency (NSA)". GCM participates in the relevant meetings regularly.

Apart from its active participation in geographic events in NATO, GCM is a member of Turkish Board of Experts on Geographical Names (BEGeoN\_T). This board is subordinated to the Ministry of Interior General Directorate of Provinces. The board is working on standardization of geographical names and also is responsible to represent Turkey in UN Geographic Names Conference and United Nations Group of Experts on Geographical Names (UNGEGN).

Within the frame of the activities of BEGeoN\_T, the list of "Turkish Exonyms of Country Names and Capitals" containing countries recognized by Turkey officially was finalized in 2012 and is published in the websites of the General Command of Mapping ([http://www.hgk.msb.gov.tr/urunler/diger/ulke\\_baskent\\_bm\\_uye\\_tr\\_tanima\\_onay\\_2012.pdf](http://www.hgk.msb.gov.tr/urunler/diger/ulke_baskent_bm_uye_tr_tanima_onay_2012.pdf))

Besides International Cartographic Association (ICA) and the UNGEGN mentioned above, GCM is also a member of EuroGeographics.